(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 429 172 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.06.2004 Bulletin 2004/25

(51) Int Cl.7: G02C 7/02

(21) Application number: 03028261.0

(22) Date of filing: 10.12.2003

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: 12.12.2002 JP 2002360987

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(54) Progressive addition power lens

(57) A progressive lens is provided, wherein the length of the intermediate corridor is in the range of 22 to 28 mm, and a clear visual region, which is defined as a region where astigmatism is 0.5 dioptres or less, has a maximum horizontal width in the far portion, which is twice or less its minimum horizontal width in the intermediate corridor. Preferably, the clear visual region has a horizontal width of 30 mm or more in the near portion. Also preferably, a position, where astigmatism distributed at the sides of the lens has the maximum value, is located in an almost horizontal direction with a far point positioned above the intermediate corridor or is located above the far point.

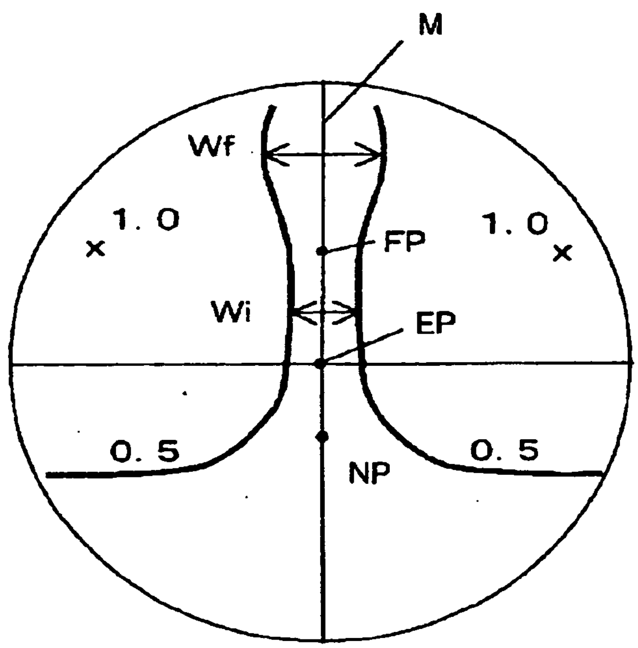

FIG.1A

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Description

[0001] The present invention is related to a progressive addition power lens which is used for close-range work such as personal computer work, bookkeeping, reading, etc., and is mainly used for patients having poor focusing ability due to presbyopia.

[0002] The general structure of a progressive addition power lens (simply referred to as "progressive lens" hereinafter) will be described with reference to Fig. 5. Fig. 5A shows the entire structure and Fig. 5B shows the variation in refractive power on the principal meridian curve M. The progressive lens has an aspheric surface, which is called a progressive addition power surface (hereinafter, referred to as a progressive surface), on any one of the pair of refractive surfaces that form a lens (conventionally, the eye side is called the inner surface and the opposite side thereof is called the outer surface). The progressive surface includes a far portion F having a refractive power corresponding to a distant view, a near portion N having a refractive power corresponding to a near view, and an intermediate portion I having a refractive power changing from that of the far portion to that of the near portion thereby connecting those two portions. It is difficult to clearly distinguish the borders between these portions because the progressive lens is continuous from the distant view end to the near view end and has no border; it is intentionally designed so that a wearer feels as if he/she is wearing normal correction glasses having a refractive power higher than conventional farsighted, nearsighted glasses, etc.

[0003] On the other hand, the refractive power along the principal meridian curve M is provided on the progressive surface on the assumption that the movement of the wearer's eyes ranges from the distant view to the near view. The lens is designed so that the wearer can move his or her eyes from a distant point in front to the very front (close range) along the principal meridian curve M and see the respective objects at each distance. Generally, the principal meridian curve M is designed to be almost perpendicular to the lens wearing state and to be angled to the nose in consideration of eye movement around the near portion N. As shown in Fig. 5B, on the principal meridian curve, the refractive power is set to be uniform in the far portion F, gradually to increase in the intermediate portion I, and to be almost uniform in the near portion N again. In general, the border between the far portion F and the intermediate portion I of the principal meridian curve M, i.e., the point FP in which refractive power starts to increase, is called far point, and the border between the near portion N and the intermediate portion I, i.e., the point NP in which refractive power is substantially constant again, is called near point. Desired refractive power variation is generated in the section which ranges from the far point to the near point, and thus this section is called an intermediate corridor.

[0004] Typically, the other surface of the progressive lens, which is not a progressive surface, is formed so as to have a spherical surface or an aspheric surface for correcting astigmatism in order to provide the wearer with prescription dioptric power in cooperation with the progressive surface.

[0005] The far portion F of the progressive surface has a constant curvature radius suitable for providing distance dioptric power, and the near portion N has an almost constant curvature radius suitable for providing near dioptric power, which is different from that of the far portion. The intermediate portion I, which smoothly connects the two portions having different curvature radii, has an inevitably complex aspheric surface, which causes the resulting unique optical characteristics of the progressive lens. That is, because astigmatism occurs on the sides of the intermediate portion I, vision through the sides is blurred. Furthermore, a distortion aberration is generated, and an object is seen to be declined and distorted when moving the head. In general, a region where the level of astigmatism is not more than 0.5 D (D=dioptres) is called a clear visual region, and it is difficult to feel blur in the region. Thus, objects in designing a progressive lens are to minimize the inevitable astigmatism and to optimize the distribution of the astigmatism in use. The same applies to the distortion aberration.

[0006] However, there are various types of progressive lens. Originally, the progressive lens had a far portion having a relatively broad region and a near portion having a narrower region than the far portion, and the length of the intermediate corridor was ten and several millimeters, i.e., this lens had a far-and-near type design. In this type, there was a disadvantage in that the clear visual region in the intermediate portion inevitably became narrow. As a result, in some cases, the dioptric power of the far portion is prescribed to conform to an intermediate length in order to make an intermediate distance appear clear, but because most of the distant view is completely sacrificed, it is impossible to obtain satisfactory vision.

[0007] Thereafter, as in JP-B-6-90368 (p.4 to 5, Fig. 1), a so-called intermediate-and-near type or near-and-intermediate type was proposed in which the length of the intermediate corridor was set to be in the range of 20 to 25 mm and the clear visual region of the intermediate portion was broadened. In this type, although it was difficult to use the far portion, it was designed to ensure that the far portion be a minimum and the visual sensation from intermediate to near distances was regarded as being important. In JP-A-9-49991 (p.4 to 5, Fig. 1), a progressive addition power band which is limited to be within 18 mm was proposed.

[0008] Thereafter, as disclosed in JP-A-2-248920 (p. 10 to 11, Fig. 13), JP-A-9-251143 (p.4 to 5, Fig. 1), JP-A-10-123467 (p.3 to 8, Fig. 11), JP-A-10-123468 (p.3 to 6, Fig. 5) and JP-A-10-123469 (p.3 to 8, Fig. 11), a progressive lens was devised in which further priority was given to the near view. In general, this type is called a

located in an almost horizontal portion of or above the far point. Moreover, when the lens is fitted in a frame of glasses, the eye point is set to be located on the principal meridian curve of the intermediate corridor at a location of 8 to 12 mm upward from the near point. As a result, it becomes possible to solve the problems described above of the conventional near-and-near type progressive lenses.

[0017] Preferred embodiments of the invention and advantages resulting therefrom will be described in detail hereinafter with reference to the accompanying drawings.

Fig. 1 is a view showing a first embodiment of the present invention, Fig. 1A indicating the aberration distribution and Fig. 2B indicating the dioptric power variation on the principal meridian curve.

Fig. 2 is a view showing the aberration of a second embodiment of the present invention.

Fig. 3 is a view showing the aberration of a third embodiment of the present invention.

Fig. 4 is a view showing an example of the conventional art, Fig. 4A indicating the aberration distribution, and Fig. 4B indicating the dioptric power variation on the principal meridian curve.

Fig. 5 is a view showing a structure of a progressive lens, Fig. 5A indicating the structure and Fig. 5B indicating the refractive power variation on the principal meridian curve.

[0018] Fig. 1 is a view showing a first embodiment of the present invention; Fig. 1A shows the aberration distribution and Fig. 1B shows the dioptric power variation on the principal meridian curve M. In this embodiment, the decrease in refractive power in the range from the near point NP to the far point FP is 1.5 D. Furthermore, the length of the intermediate corridor (length of NP-FP) is 25 mm. The maximum width Wf of the clear visual region of the far portion is 14 mm, i.e., not more than twice the minimum width Wi of 7.5 mm of the clear visual region of the intermediate portion. The clear visual region of the near portion is more than 60 mm and extends to the left and right ends of the lens. The maximum astigmatism of side portions is 1.0 D, i.e., it occurs at almost horizontal sides of the far point. The eye point EP is located at the geometric center of the lens, i.e., it is located on the principal meridian curve M 10 mm upward from the near point.

[0019] Fig. 2 is a view showing the aberration distribution of a second embodiment of the present invention. In this embodiment, the decrease in refractive power in the range from the near point NP to the far point FP is 1.0 D. Furthermore, the length of the intermediate corridor (length of NP-FP) is 25 mm. The maximum width of the clear visual region of the far portion is 14 mm, i. e., not more than 1.3 times the minimum width of 11 mm of the clear visual region of the intermediate portion. The clear visual region of the near portion is more than 75 mm and extends to the left and right ends of the lens. The maximum astigmatism of side portions is 0.7 D, i. e., it is located above horizontal sides of the far point. The eye point EP is located at the geometric center of the lens, i.e., it is located on the principal meridian curve 10 mm upward from the near point.

[0020] Fig. 3 is a view showing the aberration distribution of a third embodiment of the present invention. In this embodiment, the decrease in refractive power in the range from the near point NP to the far point FP is 2.0 D. Furthermore, the length of the intermediate corridor (length of NP-FP) is 25 mm. The maximum width of the clear visual region of the far portion is 14 mm, i. e., it is not more than 1.3 times the minimum width of 11 mm of the clear visual region of the intermediate portion. The maximum clear visual region of the near portion is 30 mm. The maximum astigmatism of side portions is 1.3 D, i.e., it is located at almost horizontal sides of the far point. The eye point EP is located at the geometric center of the lens, i.e., it is located on the principal meridian curve 10 mm upward from the near point.

[0021] The advantages of the present invention will be described in comparison with conventional near-and-near type lenses.

[0022] Fig. 4 is a view showing a specific example of what is disclosed in the above-mentioned patent documents JP-A-10-123467, JP-A-10-123468 and JP-A-10-123469. Fig. 4A shows the aberration distribution, and Fig. 4B shows the dioptric power variation on the principal meridian curve. In these examples of the conventional art, the decrease in refractive power in the range from the near point NP to the far point FP is 1.5 D, i.e., it is equal to that of the first embodiment of the present invention. Furthermore, the length of the intermediate corridor (length of NP-FP) is 19 mm. The maximum width of the clear visual region of the far portion is 50 mm or more, the minimum width of the clear visual region of the intermediate portion is 6 mm, and the clear visual region of the near portion is 35 mm or less. The maximum astigmatism of side portions is 1.4 D, i.e., it is located horizontally below the near point. The eye point EP is located at the geometric center of the lens, i.e., it is located on the principal meridian curve M 5 mm upward from the near point.

[0023] As is clear from comparing these examples of the conventional art with the first embodiment of the present invention, in the present invention, the length of the intermediate corridor is set sufficiently long so that the clear visual region of the intermediate portion can be broadened and the clear visual field can be broadened in the region of the eye point, thus making it easier to view, for example, the monitor of a personal computer.

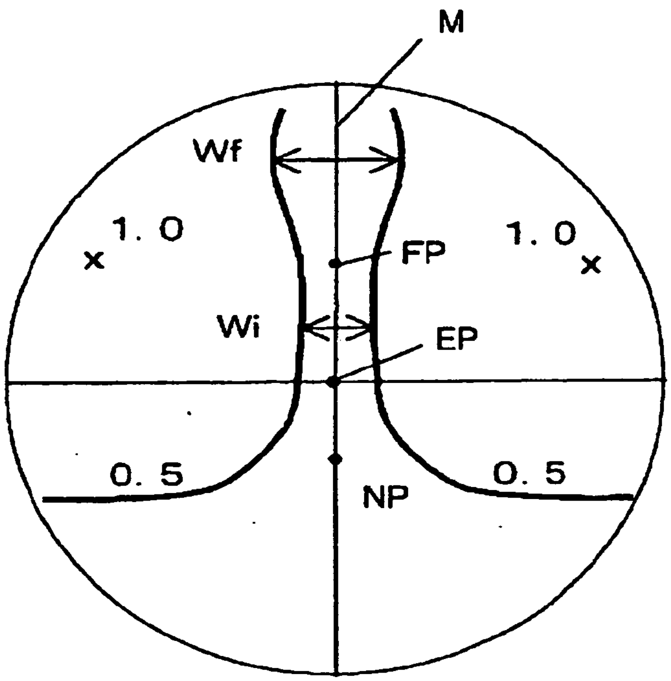

FIG.1A

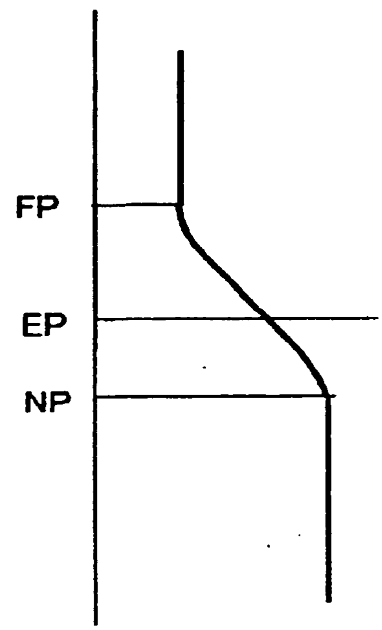

FIG.1B

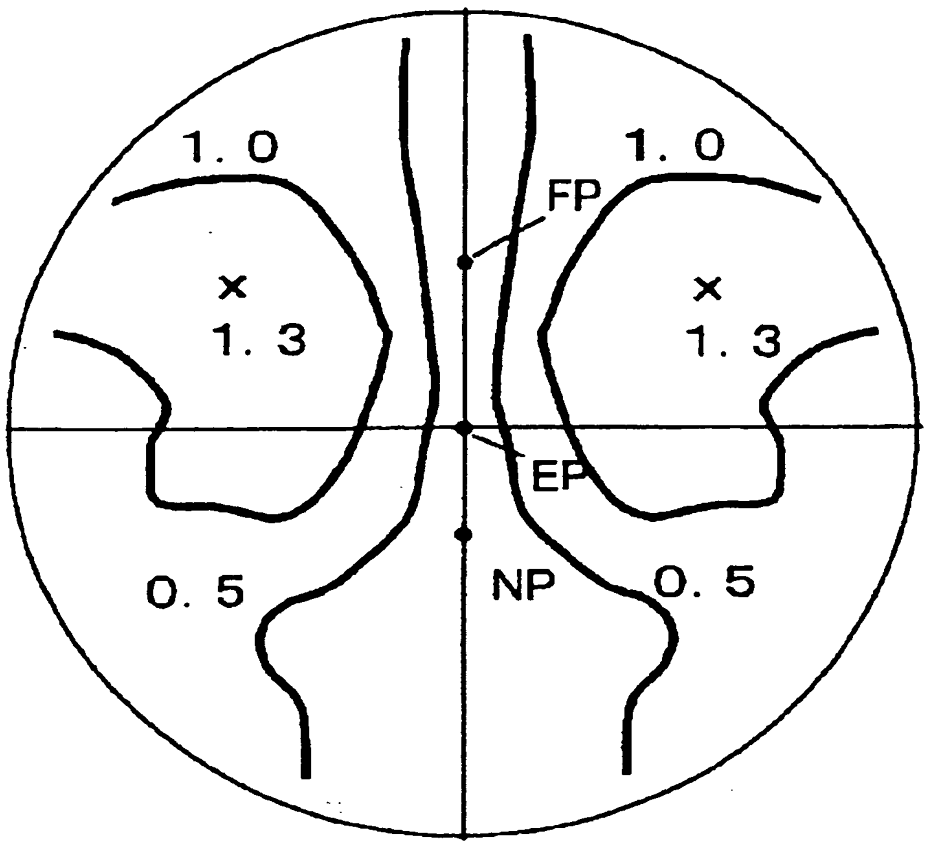

FIG.3

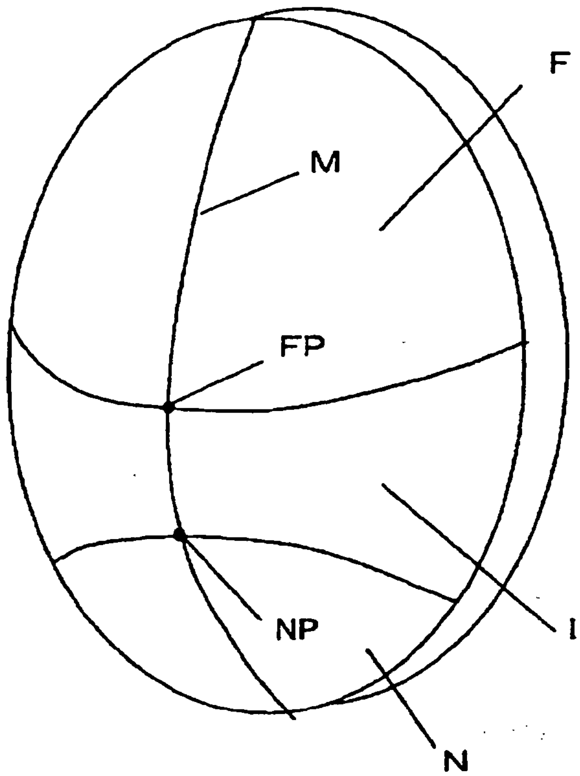

FIG.5A

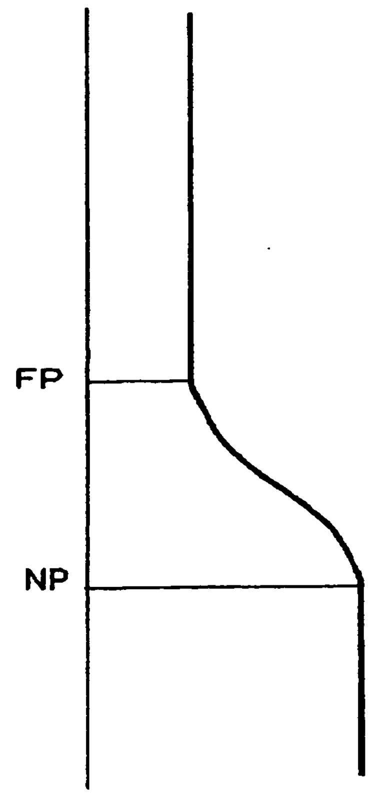

FIG.5B

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 03 02 8261

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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23-03-2004

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